Copper

Symbol:	**Cu**
Atomic Number: *(protons in nucleus)*	**29**
Atomic Weight:	**64**

What Is It? Copper is a reddish metal that can be easily molded or shaped. It is also an essential element for all living things, including humans. Because copper is an element, it does not degrade nor can it be destroyed.

How Is It Used? Copper is extensively mined and processed in the United States. It is primarily used as the metal or alloy in electrical wiring, sheet metal, pipes, and other metal products, including pennies. Copper compounds are also commonly used in farming to treat plant diseases like mildew. They are also used for treating water to eliminate algae and as a preservative for wood, leather, and fabrics.

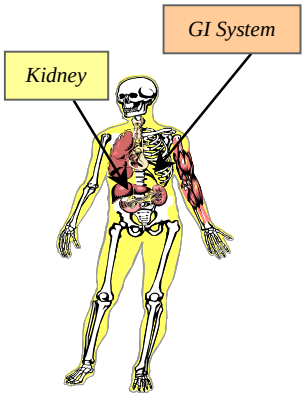
What's in the Environment? Copper is very common in the environment. It occurs naturally in rock, soil, water, sediment, and air, as well as in plants and animals. Its average concentration in the earth's crust is about 50 parts per million (ppm). Soil concentrations commonly range from 2 to 100 ppm and up to 250 ppm, but concentrations as high as 7,000 ppm have been found near copper production facilities. High soil concentrations also occur in areas where waste from sewage treatment plants or mining and other copper industries are disposed of on the soil. Considerable data indicate that copper does not biomagnify in the food chain. The typical ratio of the concentration of copper in plants to that in soil is estimated at 0.25 (or 25%). Most plants contain less than 10 ppm copper on a dry-weight basis, and concentrations in animal foods are 2 to 4 ppm, with diary products containing less than 1 ppm.

Copper is prevalent in surface water throughout the United States, with an average concentration in lakes and rivers of 4 parts per billion (ppb). Copper in aquatic systems can strongly attach to suspended particles and sediment, and it also converts to forms that are not easily absorbed after uptake or intake. The average concentration in groundwater is similar to that in surface water, with higher levels in areas with higher naturally occurring copper in geologic materials. Although it can leach through somewhat acidic, sandy soil, copper is relatively immobile in most soils. It binds more strongly to soil particles than do other divalent cations, and it precipitates out of soil water by forming solids with ions such as carbonate and hydroxide. Concentrations of copper in soil particles can range between 35 and 100 or more times higher than concentrations in water in the pore spaces between the particles. Copper is also present in drinking water, with U.S. concentrations generally ranging from 20 to 75 ppb. However, many households with older plumbing have concentrations above 1,000 ppb (or 1 part per million, ppm) because copper in the pipes and brass faucets dissolves into the water as it sits overnight.

What Happens to It in the Body? Exposure to copper can occur by breathing air, drinking water, eating food, or by skin contact with soil or water. Absorption of copper following ingestion is normally regulated by homeostatic mechanisms so that the balance between copper intake and excretion is controlled. Studies of humans indicate that in general about 50% of ingested copper is absorbed into the bloodstream, although reported values range from 15 to 97%. Water-soluble forms of copper are more readily absorbed than insoluble forms. Most absorbed copper is transported to the liver, with minor amounts going to bone and other tissues. Although it is known that copper can enter the body through the lungs or skin, quantitative data on the amount absorbed is not available. Copper exits the body mostly in the feces, as well as in the urine. It may take several days for copper to leave the body.

What Are the Primary Health Effects? In humans, copper is necessary for overall good health. People in the United States are estimated to take in 1 to 10 milligrams (mg) or more each day in their diets. The National Academy of Sciences has recommended 2 to 3 mg of copper as a safe and adequate daily intake. Copper has been shown to have a protective effect against cadmium poisoning, and people who do not have enough copper in their diet can be more susceptible to adverse effects from lead.

Drinking water with concentrations of 30 ppm or greater can cause vomiting, diarrhea, stomach cramps, and nausea. Large intakes can cause liver or kidney damage, or even death in cases of extreme exposure. People with Wilson's disease have a genetic defect that results in the accumulation of copper in tissues, including the liver, kidney, and cornea. The excess copper in this sensitive subgroup can cause damage to the kidney, liver, and brain; hemolytic anemia; and other effects. Long-term exposure to copper dust in air can irritate the nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. Adverse effects on the lungs of animal have been reported at concentrations of 0.1 to 3 ppm in air. In some people, skin contact with copper can result in an allergic reaction that is expressed as a skin irritation or rash. No data exist indicating that copper can cause cancer, and the International Agency for Research on Cancer (IARC) has stated that it is not a human carcinogen. Similarly, data do not exist to indicate that it can cause birth defects in humans.



Primary organs affected when copper is inhaled or ingested

What Is the Risk? The Environmental Protection Agency (EPA) develops toxicity values to estimate the risk of non-cancer health effects from ingesting chemicals. The toxicity value used to estimate a non-cancer effect is called a reference dose (RfD). An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. For copper, no formal RfD has been developed from toxicity studies. However, a value has been derived from the level identified as safe for drinking water. This derived value assumes that an individual drinks 2 liters of water with a copper concentration at the level identified for drinking water, every day *(see box)*. To illustrate how this value is applied, a 150-lb person could safely ingest 2.5 mg of copper every day without expecting any adverse effects (2.2 lbs = 1 kg, or 1,000 grams.) Similarly, it has also been estimated from limits established for air (see below) that an individual could breathe in 0.39 µg every day without an adverse effect.

Chemical Toxicity Value
Non-Cancer Effect: Derived Oral RfD ***(From the concentration limit established for tap water)***
0.037 mg/kg-day

What Are the Current Limits for Environmental Releases and Human Exposure? To protect against the ingestion of water or contaminated aquatic organisms (such as fish), the EPA established a water quality criterion of 1 ppm for copper in lakes and streams. The EPA has also defined a secondary maximum contaminant level (SMCL) of 1 ppm of copper for drinking water supplies. An SMCL represents a non-enforceable drinking water standard based on taste, odor, or other aesthetic considerations.

The Occupational Safety and Health Administration (OSHA) has established protective levels of 0.2 mg/m^3 of copper fume (vapor generated from heating copper) and 1.0 mg/m^3 copper dusts (fine metallic copper particles) and mists in workroom air, to protect workers during an 8-hour workday over a 40-hour work week. The National Institute for Occupational Safety and Health (NIOSH) recommends that the concentration in workroom air be limited to 0.1 mg/m^3 for copper fumes and 1.0 mg/m^3 for copper mist, averaged over an 8-hour work shift.

Where Can I Find More Information? More information on copper can be found in the primary information source for this overview: the Toxicological Profile for Copper prepared by the Agency for Toxic Substance and Disease Registry (ATSDR). Information on toxicity values is available in EPA's Health Effects Assessment Summary Tables, and several sources of information are available on the Internet, including the ATSDR ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html) and the Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).